GEWEX Radiative Flux Assessment (RFA) Update

Presenter: Takmeng Wong (NASA LaRC)

Oversite Committee: Atsumu Ohmura (ETH), Ehrhard Raschke (U. of Hamburg), William Rossow (NASA GISS), Paul Stackhouse (NASA LaRC) and Bruce Wielicki (NASA LaRC)

~75 assessment participants (TOA, surface, and both)

Local Contributors: Lin Chambers (LaRC), Takmeng Wong (LaRC), Laura Hinkelman (NIA), J. Colleen Mikovitz (AS&M), Taiping Zhang, Danny Mangosing, Yan Chen (SAIC), Juliet Pao, Walter Baskin, Churningwei Chu, Sherry King, Penny Oots, Nancy Ritchey, Tomeka Watkinson and others (ASDC)

CERES Science Team Meeting
Victoria, B.C., Canada
14-16 November, 2007
Radiative Flux Assessment Overview

• Purposes:
  – Assess our current understanding and capability to
    • derive TOA and surface radiative fluxes from analysis of satellite observations
    • validate these fluxes with surface observations
    • simulate these fluxes with models and assimilation
  – Assess uncertainties and outstanding issues in flux estimation, particularly long-term variability
    • sources include satellite calibration, input data sources, and assumptions (particularly in regards to spatial and temporal gap filling)
    • Compare surface fluxes to surface based measurements
    • intercompare existing data products
    • identify largest uncertainties and needs
  – Report methods and uncertainties to be useful for future IPCC reports on long-term data uncertainty.
  – Develop climate system observation requirements for radiative fluxes and compare to current product accuracies.
  – Assess GCM products.
GEWEX RFA Activities to Date

• 1st Workshop held (Oct. 2004 - Zurich, Switzerland)
  – Discussed issues
  – Developed pieces of draft document
  – Assigned TOA and surface groups

• Draft Document Outline
  – Proposed intercomparison activities

• 2nd Workshop held (Feb. 2006 - Williamsburg, VA)
  – Refined document outline
  – Defined surface/TOA actions and goals
  – Assigning authors

• Web Site (Rel. 1.2) Now Operational
  – Includes document framework
  – Provides for ingest and download of all data sets
  – Many data sets ingested and ready for further analysis

• 3rd Workshop held (June 2007 - New York City, NY)
  – Results discussed
  – Preliminary conclusions discussed relevant to document
  – Deadlines set for draft documents
GEWEX-RFA Data Archive

To date, data have been submitted from:

- ASRB
- BSRN
- CAVE
- CERES (ERBE-like, and SRBAVG)
- DLR ISIS
- ERBE (ERBES)
- GFDL CM 2.1
- HIRS IR (OLR only)
- ISCCP-FD
- ScaRaB
- NASA/GEWEX SRB
- U. Maryland SRB (Z. Li and R. Pinker)
- U. Oregon Surface Sites (>20 years)

Also non-standard surface data from Chuck Long.
GEWEX-RFA Results To Date

- Smith et al., 2006: ERB calibration intercomparison
- Raschke et al., 2006, GRL: SRB, ISCCP TOA comparison
- Zhang et al., 2006a,b: Near-surface meteorological and radiative properties
- Wong et al., 2006 => ERBE, HIRS, ISSCP-FD time series
- Loeb et al. (J Clim, 2007): CERES/Terra vs. ISCCP-FD, CERES/Terra vs. SeaWiFS PAR, and CERES/Terra vs. CERES/Aqua.
- SRB/CERES/ISCCP teams: Various intercomparisons
- Roesch et al. (not published): Sensitivity of monthly averages to treatment of data gaps
- Hinkelman et al. (not published): Preliminary time series analysis
- Freidenreich: GFDL model results vs. ISCCP-FD
- Schaaf: Surface albedo studies
Workshop 3: June 25-27, 2007

- About 30 participants
- New results/analysis presented
- Remaining analysis assignments more clearly defined and focused
- Strawman conclusions discussed
- Deadlines set
New discovery that the TSI is ~1361 W/m², not 1366 W/m² (TIM).

SORCE/TIM result motivated detailed examination by NIST and TSI community.
## Operational Comparison

<table>
<thead>
<tr>
<th></th>
<th>Best</th>
<th>Typical</th>
<th>Worst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuse SW</td>
<td>4.0 ± 1.4</td>
<td>8.9 ± 2.9</td>
<td>11.8 ± 3.7</td>
</tr>
<tr>
<td>Direct Normal SW</td>
<td>6.2 ± 3.2</td>
<td>13.6 ± 6.4</td>
<td>15.0 ± 6.8</td>
</tr>
<tr>
<td>Downwelling LW</td>
<td>3.3 ± 0.7</td>
<td>5.6 ± 1.4</td>
<td>7.7 ± 2.2</td>
</tr>
<tr>
<td>Downwelling SW</td>
<td>9.2 ± 4.0</td>
<td>16.1 ± 7.5</td>
<td>17.5 ± 7.2</td>
</tr>
<tr>
<td>Upwelling SW</td>
<td></td>
<td>11.1 ± 2.8</td>
<td></td>
</tr>
<tr>
<td>Upwelling LW</td>
<td></td>
<td>9.6 ± 3.0</td>
<td></td>
</tr>
</tbody>
</table>

SW Down: Noise from Multiple Sites

Surface SW Downward Flux Sampling Noise
Surface 1x1deg Grid

Hourly

Daily

Monthly

Yearly

E13

SGP 12 & 19 Sites

CAVE 44 Sites

Rutan et al
Full-sky Surface Radiation Diurnal Cycle Comparison: FD vs Observations

Diurnal Cycle from Monthly-hourly Mean: July, Averaged from 15 stations

Zhang et al
Cloud Fraction vs Direct/Diffuse Ratio: OBS [(SW derived) From 15 BEST Stations Selected from BSRN, ARM and SURFRAD] vs. FD (Cell-mean over the same locations)

Ratio of Direct to Diffuse at 3-hr-mean Local Solar Noon [All the 15 stations or eq-area cells of 2004]

Zhang et al
Multi-data Set Comparisons

All-sky Surface SW Down

[Bar chart showing comparisons of different datasets for surface SW down over different months.]

Hinkelman et al

Surface SW Cloud Effect

[Bar chart showing comparisons of different datasets for surface SW cloud effect over different months.]
## Surface Radiation Budget Results

<table>
<thead>
<tr>
<th></th>
<th>K&amp;T</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW Down:</td>
<td>198</td>
<td>178 – 198</td>
</tr>
<tr>
<td>SW Up:</td>
<td>30</td>
<td>21 – 24</td>
</tr>
<tr>
<td>SW CRF</td>
<td>–</td>
<td>-60 – -51</td>
</tr>
<tr>
<td>LW Down:</td>
<td>324</td>
<td>341 – 346</td>
</tr>
<tr>
<td>LW Up:</td>
<td>390</td>
<td>392 – 399</td>
</tr>
<tr>
<td>LW CRF</td>
<td>46</td>
<td>25 – 36</td>
</tr>
<tr>
<td>SW albedo</td>
<td>0.15</td>
<td>0.11 – 0.125</td>
</tr>
</tbody>
</table>

Hinkelmann et al
SRB, ISCCP Comparisons

- down all-sky
- down clr-sky
- cloud-effect down

Solar

- SRB sol CE is less neg than ISCCP by 2W/m2 (opt. thinner clds)

IR

- SRB IR CE is larger than ISCCP by 5W/m2 (lower altitude clds)
Kinne et al Summary

- Differences in SRB-ISCCP surface dn flux products are smaller in solar than IR
  - *alt. positioning and microphysics seem inconsist.*

- SRB-ISCCP CE differences are smaller than potential uncertainties introduced by cloud climatology differences / implementations

- IPCC CE differences from 20 different global model are ~ 3 times larger than the climatology / implementation differences
Tropical OLR Intercomparisons

Anthropogenic radiative forcing of climate is ~ 0.6 Wm\(^{-2}\) per decade

Goal ~ 0.15 Wm\(^{-2}\) per decade

1.2 Wm\(^{-2}\) calibration accuracy: current best capability (e.g. CERES)

Current spread 5 - 10 Wm\(^{-2}\); Narrows After 2001

Nong
Tropical OLR with Broadband Overlap Adjustment

Proposed adjustment uses overlap points from TRMM/Terra/Resurs, TRMM/ERBS-NS, ERBS-NS/SC, and Nimbus7-NS/ERBS

Total change to ERBS/Nimbus nearly 5 W m\(^{-2}\)
Radiative Flux Assessment Next Steps

• Data ingest and analysis
  • Continue submittal of data products from participants (particularly additional long-term surface site data - Oct. 1, 2007 => done)
  • Continue evaluation of ingested datasets against surface site data; cross comparisons; different time and space scales
  • Collection, posting, discussion of analysis results

• Assembly of Radiative Flux Assessment Draft
  • Solicit participant results and analysis for posting
  • Exchange information via news group
  • Chapter leads selected; coordinate analysis; assemble chapters with submitted results

• Collaborative draft assessment document (Jan. 2, 2008)
• Final document (to follow)
Backup
Differences for four pairs of PIRs and Departure of one other from the mean
Multi-data Set Comparisons

All-Sky LW Surface Downwelling Flux

Hinkelmann et al

LW Surface Cloud Effect
Seasonal Cycle Comparisons

Hinkelman et al
Cloud Effect (CE) Comparisons

- ISCCP
- SRB
- IPCC
- off-line
  - scaled

Kinne et al